REMARKS

Reconsideration and allowance of the subject application are respectfully requested. Claims 13-31 are now pending, claims 13, 24, and 26-31 being independent. In this Reply, Applicants have canceled original claims 1-12 without prejudice or disclaimer and have added new claims 13-31.

The Newly-Added Claims

Independent claim 13 is supported by originally filed claim 1. Additionally, it is to be outlined here that the invention, and in particular, block 803 in Fig. 8 and block 905 in Fig. 9, can be implemented into different devices. While block 803 which includes the inventive apparatus for estimating in accordance with claim 13 can be part of an encoder, the inventive apparatus for adaptive spectral whitening in block 905 from Fig. 9 can be part of a decoder. Figs. 8 and 9 show an encoder and a decoder separately from each other.

Therefore, those skilled in the art will understand the specification and the figures so that they originally disclose a separate apparatus for estimating in an encoder and a separate apparatus for producing in a decoder which naturally cooperate with each other by means of the transmitted bitstream or the received bitstream as is indicated in the respective first portions of originally filed claims 1 and 11.

The term "filter parameter" in the first paragraph of claim 13 is supported by the three mentioned filter parameters, for example, on page 2, line 17, i.e., the predictor order, the bandwidth expansion factor and the blending factor which determines the degree of mixing of the filtered signal with the unprocessed counterpart (see also page 5, line 6 of the specification as originally filed).

The second paragraph of claim 13 is additionally supported by page 5, lines 13-15, where it is outlined that the comparative study is performed on the highbands of an original audio signal and a regenerated audio signal or on the lowband and the highband of the original audio signal. Regarding the "comparative study", reference is made to page 6, line 10, and to the wording in the originally filed claim 1, where the term "tonal character" is originally disclosed.

The third paragraph of claim 13 is supported by page 2, lines 16-18, and for example, by Fig. 6, block 607, which is controlled by the parameters bandwidth expansion factor and LPC order.

Claim 14 is supported by page 5, lines 14 and 15.

Claim 15 is supported by page 5, lines 12-14, regarding the "analysis by synthesis" approach.

Claims 16-21 correspond to the originally filed claims 2-7.

Claim 23 is supported by Figs. 6 and 7 showing an apparatus for producing an output signal operating in the time domain (Fig. 6) or operating in a subband filter domain (Fig. 7).

Additionally, independent claim 24 is based on originally filed claim 1 and relates to means for obtaining the HFR unit and the adaptive spectral whitening filter by Fig. 9 and the description at the end of page 7 until the middle of page 9.

Additionally, the last paragraph of claim 24 is supported by page 1, lines 35 and 36, where it is outlined that the spectral whitening varying over time (as well as over frequency) ensures the best means to control the harmonic contents of the replicated highband. From this and from the expressions "at a given time", it becomes clear that each frame having a certain number of samples of the original audio signal obtains associated therewith one or more filter parameters for a spectral whitening filter which is situated in a decoder.

Independent claim 26 is a parallel method claim with respect to claim 13.

Claim 27 is a parallel method claim to apparatus claim 24.

Claim 28 is directed to an encoder including the inventive apparatus as defined in apparatus claim 13.

Claim 29 is an independent decoder claim including the inventive apparatus as defined in claim 24.

Claim 30 is a parallel method claim to claim 28.

Finally, claim 31 is the parallel method claim to the decoder claim 29.

The above comments are provided to detail support for the newly-added claims, but should not be relied on as limiting the claim scope based on the disclosed embodiments discussed herein.

Specification/Title

In reply to the objection to the specification set forth on page 2 of the Office Action, Applicants have made the appropriate correction by capitalizing "Gaussian". Accordingly, Applicants request that this objection be withdrawn.

Regarding the title of the invention, Applicants have amended the title to read --APPARATUS AND METHOD APPLYING ADAPTIVE SPECTRAL WHITENING IN A HIGH-FREQUENCY RECONSTRUCTION CODING SYSTEM--. Applicants respectfully submit that this new title is sufficiently descriptive of the claimed invention and respectfully request withdrawal of the objection.

Claim Objections

Pages 2-3 of the Office Action set forth a number of informalities in the originally-presented claims. Applicants respectfully submit that newly-presented claims 13-31 have been presented in a manner that addresses these informalities. Therefore, Applicants request that the claim objections be withdrawn in view of the cancellation of originally-presented claims 1-12.

Rejection Under 35 U.S.C. § 112, First Paragraph

Claims 6 and 7 stand rejected under 35 U.S.C. § 112, first paragraph as allegedly failing to comply with the written description requirement. This rejection, insofar as it pertains to the presently pending claims, is respectfully traversed.

In concluding that originally-presented claims 6 and 7 failed to comply with the written description requirement, pages 3-4 of the Office Action reason that:

> Comparison of the function "*q*" of the claims is singular while the determinant "ratios" is plural, making it problematic even with undue experimentation whether the Applicant intends for there to be multiple comparisons (one for each subband ratio "*q*") or a single comparison (with all subband ratios combined) with the "synthesized" HFR.

To the extent that this grounds of rejection applies to the newly-presented claims, particularly dependent claims 20 and 21, Applicants note that the specification describes an embodiment in which a tonal to noise ratio q is calculated for each of a plurality of subbands. See e.g., page 6, lines 15-18 of the specification. These ratios, of different subbands, are compared to determine an amount of spectral whitening. See e.g., page 7, lines 6-9 of the specification. Therefore, the specification provides an adequate written description for the claimed invention.

In view of the above, Applicants respectfully request reconsideration and withdrawal of the Examiner's rejection under 35 U.S.C. § 112, first paragraph.

Rejection Under 35 U.S.C. § 112, Second Paragraph

Claim 8 stands rejected under 35 U.S.C. § 112, second paragraph as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. This rejection, insofar as it pertains to the presently pending claims, is respectfully traversed.

The newly-presented claims have been presented in a manner that avoids the grounds for indefiniteness set forth on page 4 of the Office Action. Therefore, in view of the cancellation of claim 8, Applicants respectfully request that the rejection under 35 U.S.C. § 112, second paragraph be reconsidered and withdrawn.

A Disclosed Embodiment

A disclosed embodiment will be described with reference to Figs. 2 and 3. In Fig. 2, the lower diagram illustrates a spectrum of a certain time signal having a tonal characteristic between 0 and about 7 kHz and a noisy characteristic between 7 and 23 kHz. For coding this signal, only the lower bandwidth between 0 and 7 kHz is encoded and transmitted to the decoder. The audio coder 802 in Fig. 8 performs the encoding. One feature of this audio coder is that it filters the time signal to extract only the low band between 0 and 7 kHz.

On the decoder side, the signal between 0 and 7 kHz is again decoded (by means of element 903 in Fig. 9). The bandwidth between about 7 kHz and 15 kHz is then regenerated by means of high-frequency regeneration. This is done by, for example, copying-up the decoded low band signal between 0 and 7 kHz and by envelope-adjusting of the spectral envelope of the copied-up low band signal using the envelope information produced by element 804 of Fig. 8 and used by elements 902 and 906 of Fig. 9.

The problem of this prior art high-frequency regeneration method is that the tonal nature of the high band, i.e., the height of any peaks in the spectrum with respect to the noise floor of the regenerated high band is very similar to the tonal nature of the decoded low-band signal obtained by the audio decoder 903, since the high band is based on the low band.

When Figs. 3 and 2 are considered in comparison, it becomes clear that the high-frequency regeneration produces large errors, since the spectrum between 7 kHz and 15 kHz in Fig. 3, which is the reconstructed spectrum of the high band is extremely different from the spectrum of the original signal between 7 kHz and 15 kHz in the lower diagram of Fig. 2.

In accordance with a disclosed embodiment, the tonal characteristic of the high band is estimated and a timely-varying filter parameter of a spectral whitening filter to be applied in connection with high-frequency regeneration is determined, based on

the estimated tonal character. This filter parameter and the encoded low band audio signal are then transmitted to a decoder and, in addition, to an envelope correction. Then, copying-up of the low band takes place. Afterwards, the spectral whitening is applied to the high band data.

In this connection, the term "spectral whitening filter" means a filter, which receives, at an input, a certain signal and which outputs, as an output, a certain signal, which is spectrally more white than the filter input signal. In other words, the ratio between a peak in the spectrum of an input signal into a spectral whitening filter and the noise floor of the input signal is reduced by the spectral whitening filter, so that the output of the spectral whitening filter has a peak/noise-floor ratio, which is smaller than the peak/noise floor ratio of the spectral whitening filter input signal.

This also becomes clear from Fig. 3. The high band between 7 kHz and 14 kHz is spectrally whitened to result in the high band between 7 kHz and 15 kHz in the lower diagram of Fig. 4. It is clearly seen in Fig. 4 that the reconstructed spectrally whitened high band portion is much more similar to the original high band portion in the lower diagram of Fig. 2 when compared to the case without spectral whitening, as indicated in the lower diagram of Fig. 3 of the present application. See e.g., the paragraph bridging pages 4 and 5 of the specification.

Thus, a small extra transmitted information for the varying filter parameter results in a drastic improvement of high-frequency regeneration since, in accordance with a disclosed embodiment, the regenerated high band is not only envelope-corrected, but also "tonality" corrected.

Prior Art Rejections

Originally-presented independent claims 1 and 12 stand rejected under 35 U.S.C. § 103 as allegedly being unpatentable over *Zinser* (U.S. Patent 4,776,014) in view of *Fogel* (U.S. Patent 5,619,566) and *Sluijter et al.* (U.S. Patent 6,772,114). The Examiner relies on additional secondary references, namely *Hertz et al.* (U.S. Patent 4,361,875), *Yamasaki et al.* (U.S. Patent 5,995,561), *Lee et al.* (U.S. Patent 5,822,360), *DeJaco et al.* (U.S. Patent 5,915,235), *Kirsteins et al.* (U.S. Patent 6,249,762), *Gao et al.* (U.S. Patent 6,574,593), and *Borsuk et al.* (the article entitled "CCD Adaptive Filtering for Robust LPC Speech Processing") to reject certain dependent claims as allegedly being unpatentable under 35 U.S.C. § 103. These rejections, insofar as they pertain to the presently pending claims, are respectfully traversed.

Zinser discloses a method for pitch-aligned high-frequency regeneration in RELP vocoders.[1] With reference to Fig. 1a, an

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[1] Applicants note that various citations to portions of this reference appear incorrect. For example, reference numbers 20 and 24 do not appear in Figs. 2a and 2b. Additionally, claim 4 in column 17 of this patent does not have a line 50.

analog speech input signal is subjected to an LPC-10 analysis in element 14. These LPC coefficients output by block 16 and input into multiplexer 28 cover the whole bandwidth of the analog speech input.

By means of block 18, LPC residual signals are calculated. Importantly, these residual signals are low pass filtered in element 20. Since, as outlined in column 3, lines 38, the cut-off frequency of the low pass filter 20 is $f_{s/4}$, or even smaller, this means that the high band portion of the residual signal is completely discarded. The pitch of the low pass filtered residual signal is then determined and transmitted to the multiplexer together with predictor filtered residual samples (item 28f in Fig. 1a).

On the decoder-side, the LPC coefficients are decoded (element 44) and forwarded to an LPC synthesis filter 54. The LPC synthesis filter is excited by an input signal at node Z between items 52b and 54a. As indicated in Fig. 2, the signal at item Z is generated as follows: First of all, the residual signal is up-sampled and low pass filtered so that one obtains almost the same signal as output at elements 20. This low pass residual signal is forwarded to the combiner element 74. Additionally, a high-frequency reconstruction of the residual signal is performed. To this end and as shown in Figs. 2b and 2c, pitch carriers are calculated and modulated by means of the low band signal 63 in Fig. 2a in order to obtain the

spectrum in Fig. 2b. A high-pass filtering is then performed in order to obtain the reconstructed highband residual signal. The highband residual signal at 75 in Fig. 2c is then added to the lowband signal at 63 in Fig. 2a by means of the combiner 70 in Fig. 2 in order to result in the signal at node Z, which is used for excitation of the LPC synthesis filter.

Zinser does not use any spectral whitening at any stage in the encoder/decoder chain in Figs. 1a, 1b and 2. Thus, *Zinser* cannot disclose an apparatus for estimating a level of spectral whitening, as set forth in claim 13.

Additionally, the only signal, which is spectrally regenerated in *Zinser*, is the residual signal output by low-pass filter 20 in Fig. 1a. However, the highband portion of the residual signal is completely discarded by the low-pass filter and no tonal characteristic of the highband of this residual signal is estimated. In addition the residual signal is not the original signal, but a signal derived from an original analog speech input signal at node 10a in Fig. 1a, which is derived by LPC forward/backward filtering.

Thus, with respect to claim 13, *Zinser* does not disclose an apparatus for estimating a level of spectral whitening to be applied to a signal prior to a high-frequency regeneration step or after the high-frequency regeneration step.

Additionally, *Zinser* does not disclose any high-frequency regeneration step to be performed when generating a high-frequency regenerated signal having a highband, which is based on a lowband signal. *Zinser* also does not disclose using a spectral whitening filter. In addition, *Zinser* also does not disclose that the spectral whitening filter is an adaptive filter being adaptable by means of a filter parameter.

Additionally, *Zinser* also does not disclose an estimator for estimating a tonal character of an original signal to be encoded, wherein the estimated tonal character includes an estimated tonal character of a highband of the original audio signal, which is not included in the encoded audio signal.

Importantly, *Zinser* also does not disclose a determinator for determining a varying filter parameter of the spectral whitening filter based on the estimated tonal character. This document is completely silent about any spectral whitening filters or filter parameters for those filters.

Finally, *Zinser* also does not disclose an associator for associating the varying filter parameter, wherein the varying filter parameter is dependent on the encoded audio signal.

If this grounds of rejection is based on the assertion that the step of estimating the tonal character of the original signal is performed by the LPC analysis in block 14 of Fig. 1a, then the limitation in the second paragraph of claim 13 that the original

audio signal is to be encoded by an audio coder in order to obtain an encoded audio signal representing only a lowband of the original audio signal does not hold, since an encoded low-pass filter residual signal does not represent the lowband of the original audio signal, but can only represent something in connection with the LPC analysis parameters.

Fogel discloses a voice-activity detector for an echo suppressor and an echo suppressor. An inbound signal is input into an encoder for determining an encoded input signal to be transmitted via a communication channel. The device further includes an outbound loud speaker for outputting the voice of a far-end speaker. Naturally, the signal output by the loudspeaker 3 is received by the microphone 1 and would, therefore, without any additional further measures be encoded by the encoder 5 and transmitted to the far-end speaker via the communication channel. This would result in a very annoying echo for the far-end speaker. Therefore, transmittor-loss element 26 is provided after the inbound signal encoder in order to block the encoder from transmitting something on the communication channel when a voice activity detection device 20 detects that the signal at the inbound microphone 1 does not stem from a near-end speaker, but is the reproduction of the far-end speaker output by the out-bound loud speaker.

In order to perform a voice-activity detection, a noise whitening filter 9 is present which, as outlined in column 3, lines 19 to 24, is adapted to cancel the background noise spectrum. This adaption may be based on the LPC parameter as estimated within the encoder. A voice-activity detector logic is provided, which compares the energy of the signal leveled by the filter with respect to the background noise against a threshold.

If the signal input into the noise-whitening filter 9 is a noisy signal, then the output of the whitening filter has a very low energy, since nearly all parts of the signal has been canceled out, since the signal mainly consists of a background noise spectrum. This means that the energy of the signal leveled by the filter is very low and, thus, no voice is detected.

When, however, the signal is a voiced signal, the canceling of the background noise spectrum results in an output signal, which only has peaks without any noise floor. Firstly, this signal has a high-energy, so that a voice is detected. Secondly, and most importantly, the output of this noise-whitening filter has a more tonal spectrum than the input into this filter.

It becomes clear from this that the whitening filter in *Fogel* is a noise-whitening filter rather than a spectral whitening filter, as defined in the present invention and in the independent claims, which has, as an output, a signal, which has a spectral

characteristic being more white than a spectral characteristic of an input signal into this filter.

Additionally, *Fogel* does not teach the feature of "estimating a level of spectral whitening to be applied to a signal prior to a high-frequency regeneration step or after the high-frequency regeneration step to be performed when generating a high-frequency regenerated signal having a highband which is based on a lowband signal".

Instead, *Fogel* discloses a noise-whitening filter, resulting in a spectrally less white signal when compared to the noise-whitening filter input signal. Additionally, the filter in *Fogel* completely cancels the noise floor. When applied in the invention, it would make the situation in the lower diagram of Fig. 3 of the present application even worse. With reference to the second diagram of Fig. 4, contrary to the teaching of *Fogel*, the present invention spectrally whitens the highband signal, i.e. adds a significant noise for floor, rather than canceling the noise floor, as outlined in *Fogel*, column 3, line 20.

Additionally, *Fogel* does not have to do anything with high-frequency regeneration or with an encoded audio signal representing only a lowband of the original audio signal, as outlined in the second paragraph of claim 13.

In addition, *Fogel* does not disclose a determinator as defined in the penultimate paragraph of claim 13 or an associator as defined in the last paragraph of claim 13.

Finally, Applicants find no motivation to combine *Zinser* and *Fogel*, since it would not make any sense to filter any signal in *Zinser* such as a reconstructed signal generated by one of the carriers 66-1, 66-2, 66-i shown in Fig. 2 in order to obtain an even more tonal output signal. This would be in clear contrast to column 6, lines 58 to 60 where it is outlined that each carrier in the carrier comb is modulated by the base band data, so that the comb of modulated carrier data words are provided at modulator output. By performing any additional noise cancellation by means of the noise-whitening filter in *Fogel* at the output of the first carrier, the second carrier or any other carrier would, therefore, not make any technical sense. This is due to the fact that the output signal of the carriers 66-1, 66-2 . . . 66-i in Fig. 2 of *Zinser* does not have any noise, which could be cancelled by the noise-whitening filter 9 in *Fogel*.

Sluijter discloses an audio-transmission system in which an input signal is split-up into two spectral portions in a transmitter. The lowband spectral portion is encoded and forwarded to a receiver. The highband is LPC-encoded. Prediction coefficients of the signal in the high-frequency range are output together with signal amplitude values determined by the signal strength meter.

On the decoder-side, the highband is decoded by exciting the prediction filter controlled by the transmitted LPC coefficients of the highband and by amplitude-adjusting the LPC-filtered noise.

First of all, *Sluijter* does not relate to any high-frequency regeneration. Instead, *Sluijter* discloses a first coding algorithm for encoding a lowband portion and the second coding algorithm for encoding a highband portion. In contrast to claim 13, *Sluijter* is not related to an apparatus in connection with the high-frequency regeneration in which a high-frequency regenerated signal having a highband is regenerated, which is based on a lowband signal. As it becomes clear from Fig. 3, the highband signal at the output of the delay stage 59 in Fig. 3 of *Sluijter* is not at all related to the lowband signal, as output by low-pass filter 45. In other words, the lowband signal is not used for generating the highband signal.

However, this is in clear contrast to the inventive devices in which, for high-frequency regeneration, the lowband signal is used and adjusted using the spectral envelope parameters as well as the filter parameter of the spectral whitening filter based on the tonal character of the original signal.

In other words, the prediction synthesis filter 55 does not filter the lowband signal output by element 45 in Fig. 3. There is no connection between the lowband path and the highband path. Such a connection, however, can be seen in Fig. 9 of the application, where the output of the audio decoder is input into HFR unit 904,

which means that the signal at the output of element 906, which is input into the summing device in addition to the delayed lowband decoded signal, is of course derived by the high-frequency regeneration in which the highband signal is based on the lowband signal, as defined in all independent claims.

Additionally, contrary to the Examiner's assertions, *Sluijter* does not disclose any spectral whitening filter. The Examiner appears to assert that filter 55, i.e. the LPC-filter is the "spectral whitening filter" as defined in all independent claims. However, this is not a reasonable conclusion. Applicants note that the output of the noise signal source 49 is a perfectly white signal. It would not make any sense to further spectrally whiten this signal, since it is already a completely spectral white signal. Instead, the LPC-filter 55 produces an output signal, which has a spectral characteristic being less white than the spectral characteristic of the signal input into the LPC filter 55. Therefore, *Sluijter* as well as *Fogel*, discloses a filter, which does not spectrally whiten, but which does a kind of spectrally "un-whiten".

Therefore, *Sluijter* is not pertinent to the present invention as defined in the claims.

Additionally, one would not combine *Sluijter* with *Zinser* or *Fogel*, since *Zinser*, as well as *Fogel*, suggest an LPC-encoder for lowband (*Zinser*) or the whole band (*Fogel*), while *Sluijter*

discloses a certain LPC-based coding algorithm exclusively for the highband, but not for the lowband.

In addition, *Zinser* discloses to reconstruct the residual signal without any spectral whitening, but using the lowband residual signal, while *Sluijter* teaches to perform a stand-alone highband coding/decoding without any use of any lowband information. These two coding concepts contradict each other, so that one of ordinary skill in the art would not have been motivated to combine these references.

The Examiner's reliance on additional secondary teachings fails to make up for these deficiencies. At least for these reasons, Applicants submit that the Office Action does not support *prima facie* obviousness of any pending claim and respectfully request reconsideration and withdrawal of all prior art rejections.

Conclusion

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact the undersigned at the telephone number below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees

required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By______________________________
D. Richard Anderson, #40,439
P.O. Box 747
Falls Church, VA 22040-0747
(703) 205-8000

DRA/jdm
4441-0109P